JOURNAL OF PROCEEDINGS

UNITED STATES DEPARTMENT OF AGRICULTURE

ANNUAL CONFERENCE ON PROBLEMS OF COOPERATIVE COTTONSEED AND SOYBEAN OIL MILLS

at the

Caprock Hotel
Lubbock, Texas

March 7-9, 1955

Conference Sponsored By:

AGRICULTURAL RESEARCH SERVICE
SOUTHERN UTILIZATION RESEARCH BRANCH
New Orleans, Louisiana

NORTHERN UTILIZATION RESEARCH BRANCH
Peoria, Illinois

FARMER COOPERATIVE SERVICE
Cotton and Oilseeds Branch
Washington, D. C.

PLAINS COOPERATIVE OIL MILL
Lubbock, Texas

PROGRAM

March 7:

9:00 Opening Remarks and Announcements by:

Ward W. Fetrow, Farmer Cooperative Service, Washington, D. C.

James Crooks, Assistant Manager, Lubbock Chamber of Commerce, Lubbock, Texas

Roy B. Davis, General Manager, Plains Cooperative Oil Mill, Lubbock, Texas

10:00 Chairman: A. M. Altschul, Southern Utilization Research Branch, New Orleans, Louisiana

"Status of Program on Improving Nutritive Value of Cottonseed Meal"
A. M. Altschul, Head, Oilseed Section, Southern Utilization Research Branch

"Research on Developing New Products from Cottonseed Oil and Foots"
Leo A. Goldblatt, Oilseed Section, Southern Utilization Research Branch

"Exhaustive Extraction of Cottonseed with Hexane"
E. A. Gastrock, Head, Engineering and Development Section, Southern Utilization Research Branch

"Extractability of Raw and Cooked Cottonseed Flakes"
E. L. D'Aquin, Engineering and Development Section, Southern Utilization Research Branch

12:30 Lunch

1:30 Chairman: Allan K. Smith, Oilseeds Section
Northern Utilization Research Branch

"Utilization of Fats and Oils in Industrial Chemical Products"
Lyle E. Gast, Oilseeds Section, Northern Utilization Research Branch

"Review of Nutritional Research on Soybean Oil Meal"
Allan K. Smith, Oilseeds Section, Northern Utilization Research Branch

"Relation of Refining Treatment to Color and Stability of Soybean Oil"
R. E. Beal, Engineering and Development Section, Northern Utilization Research Branch

"Countercurrant Fractionation of Vegetable Oils"
Lyle E. Gast, Oilseeds Section, Northern Utilization Research Branch

"Research on the Processing of Soybean Oil Meal"
Allan K. Smith, Oilseeds Section, Northern Utilization Research Branch

4:30 Guided Tour and Inspection of Plains Cooperative Oil Mill

March 8:

9:00 Chairman: Ward W. Fetrow, Chief, Cotton and Oilseeds Branch, Farmer Cooperative Service

"Analysis of Operations of Cooperative Cottonseed and Soybean Oil Mills"
Daniel H. McVey, Cotton and Oilseeds Branch, Farmer Cooperative Service

12:30 Lunch

1:30 Chairman: Ward W. Fetrow, Farmer Cooperative Service

"Tax Problems of Cooperatives"
W. N. Stokes, Jr., President, Houston Bank for Cooperatives

and

C. R. Rathbone, Controller, Ranchers Cotton Oil

"Government Support Programs":

"Soybean Viewpoint"
Glenn Pogeler, Manager, North Iowa Cooperative Processing Association

"Cottonseed Viewpoint"
Roy B. Davis, Manager, Plains Cooperative Oil Mill

4:00 Conducted Tour and Inspection of Facilities of Farmers Cooperative Compress and Keeton Cattle Company

March 9:

9:00 Chairman: D. H..McVey, Farmer Cooperative Service

"New Developments in Oil Milling"
Earl Cecil, Manager, Ranchers Cotton Oil
Ed Hudson, Superintendent, Ranchers Cotton Oil
Roy B. Davis, Manager, Plains Cooperative Oil Mill

12:15 Lunch and Regular Board Meeting of Board of Directors of Plains Cooperative Oil Mill

3:00 Chairman: Ward W. Fetrow, Chief
Farmer Cooperative Service

"Membership and Loyalty Problems"
Clyde Grice, Manager, Mid-West Cooperative Oil Mill

and

Ralph Olson, President, Boone Valley Cooperative Processing Association

March 7, 1955 - Morning: Chairman, A. M. Altschul, SURB

STATUS OF PROGRAM ON IMPROVING NUTRITIVE VALUE OF COTTONSEED MEAL

by

A. M. Altschul
Southern Utilization Research Branch

This is a progress report on the cooperative research program which has been underway for some time with the objective of improving the nutritive value of cottonseed meal for nonruminants and on the work at the Southern Regional Research Laboratory which was part of this program. You will remember that cottonseed meal until very recently was used little, if at all, in feeds for poultry and swine and mixed feeds. A research program was begun to determine whether, through processing, the quality of cottonseed meal could be improved so that it could be fed in unrestricted quantities to nonruminants. A cooperative research program involving our laboratory, other research institutions, state experiment station laboratories, industrial mills and laboratories, the Fellowship Program of the National Cottonseed Products Association and its Educational Service was begun. Three public meetings were held in 1950, 1951 and 1953 to review the results of research and to recommend the new directions of research. In November, 1953, progress had been sufficient so that the conference could feel secure in suggesting tentatively that when cottonseed meal which is properly processed is mixed with soybean meal on an equal nitrogen basis growth in chicks and swine was supported as well if not superior to that which occurred when either one of these meals was used alone.

This resolution had two profound effects. It raised the status of cottonseed meal and provided a formula for using it in poultry and mixed feeds. It stimulated the interest of the cottonseed meal producers in adjusting their processing conditions so as to produce meals which more nearly conformed to the standards set by the Conference. Secondly, this resolution stimulated considerable research to prove or disprove the statements made.

In the 1954 season it is estimated that from 150 to 250,000 tons of cottonseed meal went into new markets as poultry and swine feeds. There was, of course, an unusual price situation between cottonseed meal and soybean meal which promoted such an effort. Nevertheless, this could not have been possible if cottonseed meal had not achieved the new status among nutritionists as a result of this cooperative program and if the processors had not learned to do as good a job as possible in making improved meals. It is not known whether the situation which occurred in 1954 will repeat itself, but I think it can be said that cottonseed meal is here to stay in new markets whenever the economics are favorable.

It might be worthwhile recalling the principles upon which the new developments in cottonseed meal are based. They are two: the first is that it is desirable to reduce the toxicity in cottonseed meal for nonruminants to a level where it is safe. At the present time it is felt that this can be achieved by reducing the free gossypol content in the meal to as low a possible level. The second principle is to minimize the heat damage to the meal during processing. Some relationship has been established between minimum heat damage and solubility of the nitrogen in dilute alkali. This has been a rough measure of the extent of heat damage. While the actual measure of toxicity and heat damage,

that is free gossypol content and nitrogen solubility, will unquestionably be modified as the information about cottonseed meal increases, there is reason to believe that these two principles involving minimizing the toxic material as well as minimizing heat damage are sound and will remain. Adherence to these principles has gained many new markets for the cottonseed meal industry which could possibly be extended as time goes on.

Aside from its practical value to the industry, this research program is an interesting example of teamwork between a wide variety of scientists, chemists, nutritionists, practical mill operators, and engineers as well as teamwork between various groups such as exist in government and industry. It is an object lesson of what can be achieved in one industry when such cooperation is achieved. It might well serve as a model in attempts to solve other problems.

RESEARCH ON DEVELOPING NEW PRODUCTS FROM COTTONSEED OIL AND FOOTS

by

L. A. Goldblatt
Southern Utilization Research Branch

When the chemist looks at most vegetable oils, he finds a great many points of similarity between the various oils as well as some individual, and frequently characteristic variations. For example, the chemist finds that practically all vegetable oils are glycerides. Whether the oil is cottonseed oil or olive oil or soybean oil or safflower oil or tung oil, better than 95% of the oil is composed of derivatives of glycerine. Glycerine is the stuff from which the explosive manufacturers make dynamite and cosmetic people make hand lotions and others use for a great many different purposes that may range from storing blood to keeping cigars from drying out.

Of the glyceride in vegetable oils only about 10% is glycerol and the other 90% is fatty acid. There are a great many fatty acids but four or five comprise by far the greatest proportion of all the fat in vegetable oils. Table I gives the name and chemical formula of these acids. They are stearic acid, oleic acid, linoleic acid, linolenic acid and palmitic acid. The chemical formulas of these acids are also given in Table I.

Table I

Some Important Acids Present in Vegetable Oils

Stearic Acid	$C_{17}H_{35}COOH$
Oleic Acid	$C_{17}H_{33}COOH$
Linoleic Acid	$C_{17}H_{31}COOH$
Linolenic Acid	$C_{17}H_{29}COOH$
Palmitic Acid	$C_{15}H_{31}COOH$

$$CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH{-}CH{=}CH{-}CH_2CH_2CH_2CH_2CH_2CH_2CH_2COOH$$

Oleic Acid

The first four of these acids all start with the formula C_{17}. That indicates how closelyrelated they are. Cottonseed oil is about 50% linoleic acid and 25% oleic acid and contains substantially no linolenic acid. Safflower oil is about 75% linoleic acid and 10% oleic acid with no linolenic acid. Soybean oil is comprised of about 55% linoleic acid, about 25% oleic and perhaps 7% linolenic acid. Linseed oil is about 20% linoleic, 25% oleic and 50% linolenic. Corn oil is about 30% oleic and 55% linoleic acid, with very little, if any linolenic acid. Beef fat or tallow is very rich in stearic acid and oleic acid. Approximately 25% of cottonseed oil is palmitic acid. It is rather unusual in being relatively rich in palmitic acid in comparison with most vegetable oils.

At the bottom of Table I is shown the structure of a molecule of oleic acid, that is, the architectural plan of oleic acid. It consists of 18 carbon atoms in a row. The two end carbon atoms are a little different from the other and the two middle ones, at carbons 9 and 10 (counting the C in COOH as number 1) are a little different. The carbon atom at the left hand end has three hydrogen atoms attached to it instead of two like most of the others and the carbon at the right hand end has two oxygen atoms attached to it. The carbon atoms 9 and 10 have only one hydrogen atom apeice instead of two like all the rest. In place of those two hydrogen atoms, there is what chemists call a double-bond, or a center of unsaturation. The only different, chemically, between oleic acid and stearic acid is that double bond. If those two carbon atoms in the 9 and 10 position had each one more hydrogen atom, you have stearic acid instead of oleic acid. If you want to look at it that way, oleic acid is stearic acid from which two hydrogen atoms, from the 9th and 10th carbons, had been clipped off. To make linoleic acid two more hydrogen atoms would be removed. In this case, one hydrogen atom from carbon 12 and another from carbon 13, and linoleic acid would have two double bonds, one at carbon 9-10 and the other at 12-13. To make linolenic acid, we would clip off two more hydrogen atoms -- this time at carbons 15 and 16 and linolenic acid has three double bonds between carbons 9-10, 12-13, and 15-16. To make palmitic acid, carbon 9 and 10 would be clopped out all together and that would leave only the 16 carbons that you see in palmitic acid. That indicates how closely related these various acids are. Chemically, the essential difference between cottonseed oil, safflower oil, soya bean oil, linseed oil, or corn oil, is in the relative proportion of the C-18 and C-16 acids. All the other differences in composition are very small in proportion and amount to certainly less than 5%.

Originally, these various oils were used for specific purposes primarily because of these differences in composition. Small though they are chemically, they result in major differences in properties. Linseed oil with a lot of linolenic and linoleic acid is unsuitable as an edible oil but it makes a good drying oil for paints and varnishes. Cottonseed oil with no linolenic acid but a lot of oleic and linoleic acid make a good edible and salad oil but is not good as a drying oil. Soybean oil is in-between. It contains some linolenic acid which makes it a semi-drying oil and large proportions of oleic and linoleic acid which makes it an edible oil.

As time went on, chemists learned more and more about how to interconvert these various acids. You have all heard of the process of hydrogenation. That process has been used industrially for the hydrogenation of oils for 50 years. In that time chemists have learned more and more how to control the pattern of hydrogenation. The effect of this and the development of other technical processes and processing techniques, such as ester interchange, and better control of oxidative and flavor stability has been to make it easier and therefore less expensive to interconvert the various oils. Another result is that the prices of these oils have tended to come closer together. The most recent issue of the Fats and Oil Situation, a publication of the Agricultural Marketing Service, has some data that is very striking. They listed, among other things, the current price of numerous oils together with the price two years ago. The prices of about ten of these oils are shown in Table II.

Table II

Prices of Various Oils

Oil	Price - Cents per Pound December 1952	December 1954
Corn, crude, Midwest	14.4	13.2
Cottonseed, crude, S. E.	14.0	12.9
Lard, prime, Chicago	8.1	13.5
Linseed, raw, Minn.	14.8	12.7
Oiticica, drums, New York	26.6	16.5
Oleo oil, drums, New York	11.8	18.7
Peanut, crude, S. E.	25.1	19.2
Soybean, crude, Midwest	12.9	12.5
Tallow, edible, Chicago	6.3	11.2
Tung, New York	34.2	20.7
Spread of Ten Oils	6.3-34.2	11.2-20.7

The particularly significant thing about this table is that the low priced oils are the ones that have especially gone up in price; the high priced oils are the ones that have come down in price so that the range has been greatly narrowed. Instead of a range from 6.3 to 34.2 cents per pound, the range is now from 11.2 to 20.7 cents. A range of about 500% has gone down to a range of less than 100% and at least some of that range is due to geography; that is, the price in New York as against the Southeast as against the Midwest.

Doubtless at least some of this decreased range has been due to improved knowledge of chemical processing and the increased interconvertibility of the oils. The day of extreme differences in price of different major oils seems ended. Linseed oil cannot differ too much in price from soybean oil or the equivalent will be made from the cheaper oil. Cottonseed oil cannot differ too much in price from soybean oil, or corn oil, or again the equivalent will be made from the cheaper oil. The fact is that from a chemical point of view most of the vegetable oils with which we have to deal are essentially interconvertible. Any new chemical product developed from cottonseed oil can also be made from soybean oil, or lard, or peanut oil and at different times economic factors might favor the use of different oils.

What we have is a tremendous pool of literally billions of pounds a year of oils that are interconvertible and thus tend to have price stability that is a distinct advantage for industrial utilization. While we have various compartments in this pool, cottonseed oil in one and soybean oil in another for example, the barriers between the compartments break down if the differential is too great. For all practical purposes we have one pool of oil. Anything that is developed that helps the utilization of one oil helps all the oils. Any chemicals developed at the Southern Regional Laboratory to help the use of cottonseed oil also help soybean oil, any chemical development of the Eastern Regional Laboratory which helps the utilization of animal fats also helps cottonseed oil and soybean oil.

We have a very good illustration of this interconvertibility in the case of the acetoglycerides pioneered by Mr. Feuge's Oil Processing group in the Oilseed Section of the Southern Regional Laboratory. You will recall that the vegetable fats are better than 90 or 95% glycerides of the long chain, C-18 and C-16 fatty acids. A few years ago, at the Southern Laboratory it was observed that if some of the long chain acids of cottonseed oil is replaced with acetic acid (that is the acid that is present in vinegar and it has only two carbon atoms in the chain instead of 16 or 18) the products are very different physically. If you take hydrogenated cottonseed oil and replace some of the fatty acids with acetic acid you get a solid — but the solid instead of being brittle or having a greasy feel, typical of a fat, is flexible and waxy. If you replace some of the C_{18} acid of the unhydrogenated cottonseed oil with acetic acid you get oils that stay liquid even at very low temperature.

These products are called acetoglycerides. They are fats, but they are a new kind of fat that nature doesn't make. Presumably they would be completely edible because the only new thing added is acetic acid. That is the acid component of vinegar and we all use more or less vinegar with our food. What are the acetoglycerides good for? Well, they are being evaluated as coatings for all kinds of food products from hot dogs to cheese; from raisin bran to slab dressings in the making of candy. They are being evaluated as plasticizers for various kinds of resins - particularly for plastics to be formed into sheets or film and used as a wrapper for food products.

A particularly interesting application is in the production of a global edible spread for the Armed Forces. They want a spread with a long plastic range, that is, one that is spreadable, for example on bread, just as well in Alaska as in North Africa and will be acceptable after storage for at least six months at 100°F. temperature. These requirements can be met by a mixture containing an acetoglyceride, and the product can be made to resemble ordinary margarine in appearance and taste. The Armed Forces are definitely interested in this product and have prepared specifications for procurement of a trial batch of such a spread. The acetoglycerides cannot be recommended for food use until definite proof of edibility has been established in thorough and extensive tests by qualified pharmacologists and nutritionists. Such proofs have not yet been obtained. The necessary tests have been initiated and in at least one case have been underway for a period of over two years, but they have not yet been completed. The Food and Drug Administration has approved their use for cosmetics, including shampoos, but has not yet approved their use as food.

These acetoglycerides were developed by Mr. Feuge's group from cottonseed oil. At present at least two companies are making them, possibly more, but initially at least they were made from lard rather than from cottonseed oil. But bear in mind that what helps lard helps cottonseed oil too. A few years ago, the chemists at the Northern Regional Laboratory developed a process for dimerizing the linoleic acid of soybean oil to make what they called dimer acid. That consists of two linoleic acid molecules hooked together to make a still bigger molecule. Today a very considerable amount of dimer acid is being made by at least one company for the production of various resins, but most of the linoleic acids for this purpose is coming from cottonseed oil foots rather than from soybean oil. In the same way the Eastern Regional Laboratory developed a process of treating various fatty acids and fats with hydrogen peroxide to make a type of material called an epoxide. These epoxidized oils were found to be effective stabilizing plasticizers for polyvinyl chloride resins. These resins are used in anything from garden hose to wall tile. Today millions of pounds of oils are being epoxidized for this purpose but these epoxidized oils are made chiefly from soybean oil. So that closes the circle. The Southern Laboratory used cottonseed oil to make acetoglycerides and the product is being made from lard; the Eastern Laboratory developed epoxidized oils and they are being made from soybean oil; the Northern Laboratory developed dimer acids and that is being made from cottonseed. The significant thing really is that we have a pool of fats and oils. It is a tremendous pool of billions of pounds of oil. Anything that helps withdraw any oil from the pool helps all because they are all essentially interconvertible. Which particular oil will be used for any particular purpose will depend upon geography or a particular company's interest and economic factors as well as the chemistry of the oil and its price.

As you know, in recent years there has been a considerable development of the addition of fat to animal feeds. That development was sparked a few years ago by work at the Eastern Regional Laboratory looking towards the addition of inedible animal fat to feeds to increase their nutritive value. At present, such fats are sometimes added to feed to improve their pelleting properties or to decrease dustiness. For that purpose, of the order of one or two percent of fat is commonly added to the meal. To increase nutritive value more commonly of the order of five or six pervent of the fats are added to the feed. Do these fats have to be animal fats? Not necessarily. Why not add back crude cottonseed oil, or better, the material that is removed when you refine crude cottonseed oil, that is, soapstock? At the Southern Laboratory we have been doing some work with soapstock and are considering this possibility. One of the disadvantages of cottonseed soapstock for this purpose is its gossypol content. As you know, crude cottonseed oil contains more or less gossypol. This material is toxic and is removed from the crude oil during the refining and goes into the cottonseed oil soapstock.

Table III shows the gossypol content of some of the soapstocks we have examined. The gossypol also carries over into many of the acidulated cottonseed soapstocks or acidulated foots that we have examined.

Table III

Gossypol Content of Some Typical Soapstock

Sample	Gossypol Free	Gossypol Total
Alkaline Soapstock A	3.9	4.4
Alkaline Soapstock B	2.3	2.8
Alkaline Soapstock C	1.1	1.4
Alkaline Soapstock D	0.34	0.45
Acidulated Laboratory A	6.0	6.0
Acidulated Commercial A	0.15	0.38
Acidulated Commercial B	0.42	0.42

We have tried various ways of destroying the gossypol. We have tried treating it with various chemicals as well as with heat. Normally, excessive amounts of chemicals are required and heat alone at temperatures up to 100°C. is relatively ineffective. Table IV shows what happens to the gossypol when you heat cottonseed oil foots for various lengths of time at about 100°C. If you blow air through it at the same time it doesn't help the foots any but doesn't seem to do the gossypol much harm. However, Mr. Pack at the Southern Regional Laboratory, developed a very convenient way of destroying the gossypol in cottonseed foots by heating them at a high temperature for a short period of time. At a temperature of 200 or 210°C. (that is about 400°F.) the gossypol is practically completely destroyed in one or two minutes. Table V shows the effect of a short heating time at about 200°C. on the gossypol content of foots and you will note that it takes only a minute or two at 210°C. to decrease the gossypol content to 0.

Table IV

Effect on Alkaline Soapstock of Heat Treatment (100°C.) plus Air-Blowing*

	% Gossypol Free	% Gossypol Total
Control	2.31	2.81
2 hours	1.90	2.71
4 hours	1.76	2.40
19 hours	0.48	0.96

* Air-blowing at the rate of five cubic feet per hour per pound of soapstock for the first four hours only.

Table V

Effect of Heating Alkaline Soapstock at Temperatures above 100°C.

	% Gossypol	
	Free	Total
Control	3.76	4.20
180°C. (4 minutes)	0.54	0.67
190°C. (4 minutes)	0.15	0.16
200°C. (4 minutes)	0	0
210°C. (2 minutes)	0	0
220°C. (1 minute)	0.30	0.44
220°C. (2 minutes)	0	0
240°C. (1 minute)	0.15	0.32

Unfortunately, since cottonseed soapstock is about 50% water, to get a temperature of 200°C. one would either have to remove all the water or use equipment that would withstand the pressure generated by water at a temperature of 200°C. That amounts to about 200-225 lbs. per square inch. At the Southern Laboratory, in cooperation with the Engineering and Development Section, a small pilot plant has been built to process foots at this temperature. This process should permit the complete removal of gossypol from cottonseed soapstocks and permit the addition of acidulated, treated cottonseed soapstock to rations even for laying hens where extremely small quantities of gossypol would result in egg yolk discoloration.

I would like to revert back now to Table I that shows the formulas of the major acids and the structural formula of oleic acid. I would also like to emphasize again the essential interconvertibility of these acids. What can be done chemically to one, can in general be done to another. When the chemists looks at these acids he sees immediately two points of attack from a chemical point of view. These two points are first the COOH end (he calls the COOH group a carboxyl group) and second the point where the two hydrogens are missing, the double bond. These are the two obvious points of attack for the chemist to go to work.

In the past, the chemist has devoted most of his effort to the carboxyl part. From this he has made all kinds of soaps; for example, sodium and potassium soaps that are used for washing purposes or for cleansing; the aluminum and magnesium soaps that are used for greases; or cobalt and manganese soaps that are used for driers for paints or printing inks; or zinc soaps that are used for surface coatings, or in rubber or dusting powders; or copper soaps that are used as fungicides. Something we have been working on at the Southern Laboratory is the production of chemicals directly from cottonseed oil soapstock. As you know, refining the crude cottonseed oil consists essentially of treating the crude cottonseed oil with caustic soda or soda ash. One of the most important things that happens chemically in the refining of the crude oil is that the free fatty acids in the oil react with the soda to produce soap, a sodium soap. The most important component of cottonseed oil soapstock obtained by the refining of crude cottonseed oil is soap. Unfortunately, it is contaminated with so many other things that it can not be used for most of the purposes for which soaps are used.

We have tried to react the soapstock with various organic compounds. The formula for a typical soap would be $C_{17}H_{33}COONa$. We have reacted these soaps with various chlorides; for example, benzyl chloride $C_6H_5CH_2Cl$. A reaction takes place to split out NaCl which is ordinary table salt and the other two parts get together to produce what is known as an ester. In this particular case it would be a benzyl ester or more particularly benzyl oleate. This would be indicated by a chemical equation as follows:

$$C_{17}H_{33}COONa + ClCH_2C_6H_5 \longrightarrow NaCl + C_{17}H_{33}COOCH_2C_6H_5$$

Sodium oleate Benzyl chloride Salt Benzyl oleate

We take the soapstock and treat it with benzyl chloride, filter off the sodium chloride and a lot of other gunk that goes with it and then distill out the benzyl oleate from the product. This benzyl oleate has been tested as a plasticizer for polyvinyl chloride. It is not a good primary plasticizer because it is not completely compatible with polyvinyl chloride but mixed half and half with a standard plasticizer such as dioctyl phthalate it is compatible. The properties of such a plasticized polymer are shown in Table VI.

Table VI

Evaluation of Benzyl Esters as Plasticizers for Polyvinyl Chloride

50% ESTER 50% (DOP)		DI-OCTYL PHTHALATE
2920	tensile strength (p.s.i.)	2920
1580	100% modulos (p.s.i.)	1560
290	elongation (percent)	300
-45.0°C.	brittle point	-31.0°C.

You will note that it gives the resin about the same physical properties as does pure dioctyl phthalate but has a significant advantage of having a brittle point lowered from about -31° to -45°. Benzyl oleate is just one representative of a whole class of chemical compounds that are known as esters that can be made from fatty acids. We have made a number of other esters directly from soapstock in this way, for example the methyl benzyl esters and dimethylbenzyl esters. Esters can be used for anything from lubricants to alkyd resins for paints and varnishes.

There are a great many other things that can be done with a carboxyl group. Some of these are shown in Table VII.

Table VII

Some Products that can be made by Modifying the COOH Group

$C_{17}H_{35}COOH$	Stearic Acid
COOM	Metal Salt
COOR	Organic Ester
$CONH_2$	Amide
CN	Nitrile
CH_2NH_2	Amine
CH OH	Alcohol
———	Hydrocarbon

For example, the acids can be converted to nitrogen containing compounds. Chemically several different classes of nitrogen compounds can be made. They include amides, nitriles, and the amines illustrated in Table VII. Each class has its own particular properties and uses. They are used for anything from flotation agents for ores to fungicides.

A novel twist that has been introduced recently is to remove the carboxyl group altogether to give what are known as hydrocarbons - that is chemicals containing only carbon and hydrogen. The chief source of hydrocarbons in this country is petroleum. For years the petroleum chemists have been envying the fat chemists because the petroleum people have hydrobarbons to work with and no really good handle such as the COOH group which the fat chemists have with which to get hold of them. So, one group of chemists at a major industrial concern developed a process for knocking off this carboxyl group to give a hydrocarbon to be used in competition with hydrocarbons produced by the petroleum industry. Now they advertise the availability, in pilot plant quantities, of these hydrocarbons from fat and suggest ways of using them for making anything from corrosion inhibitors and lubricants to insect repellents and diesel fuel additives.

So far we have dealt only with what the chemist can do with the carboxyl end of the fatty acids. The double bond in the middle presents an even larger number of possibilities for the chemist. The chemistry of the double bond is perhaps a little more intricate than is the chemistry of the carboxyl group so that the technology of the double bond chemistry is not as far advanced. Some reactions that have been used are shown in Table VIII.

Table VIII

Some Reactions of the Double Bond

$CH_3(CH_2)_7-CH=CH-(CH_2)_7COOH$	Oleic Acid
$-CH_2-CH_2-$	Hydrogenated
$-CH-CH-$ (O)	Epoxidized
$-CH_2CH_2-$	Dimerized
$-C=CH-$	
$CH_3(CH_2)_7COOH$ + $HOOC(CH_2)_7COOH$	Ozonized
Pelargonic Acid Azelaic Acid	

The simplest chemical reaction of the double bond is to add hydrogen to it thereby removing the double bond. As you know, that reaction has been carried out industrially for more than 50 years to produce hydrogenated cottonseed oil for shortening, margarine and other products. In recent years more and more has been learned as to how to control the addition of hydrogen so as to hydrogenate certain double bonds selectively. This is done in order to produce certain specific properties in the products no matter whether you start with cottonseed oil, or peanut oil, or soybean oil.

Hydrogenation is the simplest reaction. The dimerization reaction that was mentioned previously as having been developed at the Northern Regional Laboratory is a very special kind of double bond reaction where instead of adding two hydrogen atoms at the double bond, a hydrogen atom from one molecule is added to one end of the double bond of another molecule and all the rest of the first molecule is added to the other end of the double bond of the second molecule. The epoxidation reaction that was mentioned as having been developed at the Eastern Laboratory is a type reaction whereby one of the oxygen atoms of the hydrogen peroxide adds to the double bond just as two atoms of hydrogen would, and the other product in this case is water. That sounds very simple and the chemistry is simple, but when you try to carry out the reaction in the laboratory or plant it isn't quite that simple. Much work had to be done to determine the right solvents, temperature, concentration and other operating conditions to get good yields.

If ozone is used instead of hydrogen peroxide, quite different products are obtained. Ozone is produced by passing an electric discharge through air. The odor sometimes detected around sparking electrical equipment is due to ozone. If oleic acid is treated with ozone it breaks apart at the double bond to produce two brand new acids. One, $C_8H_{17}COOH$ is pelargonic acid and the other $HOCC(CH_2)_7COOH$, which is azelaic acid. This is a highly valued dicarboxylic acid that has a great many industrial uses. A large company is now producing azelaic acid commercially in this way.

At the Southern Regional Laboratory we have been carrying out an exploratory project on the reactions of the double bond and trying out a considerable number of different possible reactions especially with linoleic acid. We have found several that seem promising. Details haven't been worked out yet, but they seem promising from the point of view that the products have interesting properties and it appears that they can be made in reasonable yields without too much difficulty.

I would like to touch on just one of these pieces of work that is being carried on at the Southern Laboratory.

That is work we are doing on shifting the position of the double bond. Why should anyone want to shift the double bond? Consider the case of oleic acid. The double bond is at the nine position, that is between carbons 9 and 10. When that is treated with ozone a 9 carbon atom dicarboxylic acid is produced, azelaic acid. Suppose the double bond is shifted over to the 10-11 position and that is treated with ozone. The product would then be a dicarboxylic acid with 10 carbon atoms and that is sebacic acid. Sebacic acid is now made from castor oil and costs something like 70 cents a pound as against 35 cents a pound for azelaic acid and perhaps 15 cents for oleic acid. Yet, millions of pounds of sebacic acid are produced annually to make anything from engine lubricants to special kinds of nylon. If the double bond of oleic acid is shifted to the 6-7 position and that is treated with ozone the product is a 6 carbon dicarboxylic acid. That acid is known as adipic acid and that is the acid from which nearly all nylon is made. Correspondingly, if the double bond were shifted to other positions along the chain and those products treated with ozone other dicarboxylic acids would be produced. These would have their own special properties and would surely have their own special uses for particular purposes.

At the Southern Laboratory we are also trying to learn how to shift the double bonds not only in oleic acid but also in linoleic acid. Here we have two double bonds, at the 9-10 and the 12-13 carbon atoms. Such a system has its own special properties owing to the fact that the CH_2 between the two double bonds is especially reactive. But if one of these double bonds could be shifted one carbon closer to the other one, there would be produced what the chemists call a conjugated system - that is, an alternating system of double and single bonds as shown in Table IX.

Table IX

Structure of Linoleic Acids

Linoleic Acid

$H_3C(CH_2)_4-CH=CH-CH_2-CH=CH-(CH_2)_7COOH$

$H_3C(CH_2)_4-CH_2-CH=CH-CH=CH-(CH_2)_7COOH$

Conjugated Linoleic Acid

Such a system, a conjugated system, has a chemistry all its own. Such a system would dry very readily and would result in more rapid drying varnishes, for example. Moreover, such a system is especially reactive chemically. A characteristic of such a system is that it will react in a readily predictable fashion with literally hundreds of different organic compounds by what is known as the Diels-Alder Reaction. This type of reaction, which is characteristic of conjugated systems, was discovered by the two chemists Otto Diels and Kurt Alder. For this discovery they won the Nobel Prize in Chemistry a few years ago. Since the discovery of this reaction literally hundreds of papers have been published describing chemical reactions applicable to conjugated double bond systems and some of these products have found very extensive use industrially. For example, some of the major insecticides are made by use of this type reaction. At the Southern Laboratory we are investigating some of the possibilities of the Diels-Alder Reaction applied to conjugated linoleic acid with the thought that the products are potentially useful industrial chemicals- useful for example as emulsifiers, lubricants, plasticizers or pesticides.

To summarize: First, by reason of increased knowledge of the chemistry of the fats and the fatty acids, the interconvertibility of the various fats and oils has been increased tremendously. Instead of using a particular oil for a particular purpose because it's physical and chemical properties are the ones most nearly meeting the requirements of that use, other oils can be modified chemically and without too much difficulty to possess those same properties or perhaps even a more desirable balance of properties. So we have a tremendous pool of fats and oils that are interconvertible. That tends to stabilize prices and what helps one oil helps all. It is fatty acid chemistry rather than cottonseed oil or soybean oil chemistry. Second, there is now in existence a very large industry based on the chemical modification of fatty acids to produce chemical derivatives for industrial use. This technology has increased greatly in recent years. I have tried to give you some impression of the tremendous number of possibilities for chemical modification of the fats and fatty acids that has not yet even been looked into. It is difficult to say in advance which particular products are going to find industrial uses or sometimes even what they will be good for. But certainly, if the past is any criterion of the future we can be sure that many of these chemical derivatives that have not yet been prepared will find some niche for which they are especially adapted and they will then find their place as industrial chemicals.

EXHAUSTIVE EXTRACTION OF COTTONSEED WITH HEXANE

by

E. A. Gastrock
Southern Utilization Research Branch

Solvent extraction of cottonseed to a residual oil content in the range of 1.5% to 2.5% is accomplished with relative ease and rapidity. Continuing the extraction to residual values of 0.5% or lower becomes increasingly more difficult and expensive to accomplish.

The degree of extraction affects oil yield, oil quality, meal quality, plant capacity, and unit costs. Other factors to consider are seed variety, seed quality, the kind of preparation, and the type of processing used. Commercial processors wish to know the residual oil value below which they are not justified in going.

My report today deals only with direct extraction. It emphasizes oil quality and includes some discussion of oil yields. A prime cottonseed of medium oil content was used for the tests. It was 1953 crop year seed from the Greenwood, Mississippi, area. The oil content of the hull-free whole meats was 33.45%. Whole meats were used as nearly hull-free as could be produced without hand picking. The whole meats were prepared for extraction by three different methods of meats preparation as follows:

(1) Raw flaked meats: The meats were flaked to a thickness of Ca. 0.010 inch and used "as is" with no moisture addition, drying, or other treatment.

(2) Filtration-Extraction cooked meats: The meats were flaked to Ca. 0.008 inch thickness, their moisture increased to 21% - 22% in the top ring of the 5-high cooker then cooked for a total residence time of 48 minutes with maximum cooking temperatures of 225-226°F. The cooked meats were cooled and crisped by evaporative cooling.

(3) Tempered meats: The meats were cracked through a single set of Allis-Chalmers cracking rolls set at 0.040 inch and then tempered by heating for 23.5 minutes with temperatures increasing gradually from 110°F. to 170°F. The tempered cracked meats were flaked immediately to 0.008 thickness.

Extraction Procedure: Commercial hexane having a boiling range of 68-70° C (154.4-158°F.) and a negligible residue by evaporation was used for all extractions.

1/ Based on a paper prepared by P. H. Eaves, E. L. D'Aquin, J. J. Spadaro, A. J. Crovetto, V. O. Cirino, C. L. Hoffpauir for presentation at the AOCS meeting in New Orleans, Louisiana, April 18-20, 1955.

For each extraction 80 pounds of prepared meats were charged to the extractor cell, which was heated with circulating water at 120° ± 4° F. in the jacket. The meats were covered to a uniform depth of 4 inches with hexane heated to 120° ± 2°F., permitted to soak, and the miscella then pumped out via the bottom outlet as rapidly as possible; the prepared meats were again covered with solvent and the procedure repeated. A total of about 15 such extraction passes, using a soaking time of 5 minutes each, were made with each of the materials. The residual lipids of the partially extracted material was then determined and, if above 0.5%, additional extraction passes with longer soaking times as required were made.

The miscella from each extraction pass, or from two successive passes, was collected, weighed and analyzed for lipids content. Then after determining the final residual lipids content for the meal from each run it was possible to calculate the residual lipids remaining in the meal after each combination of successive extraction passes.

Next by appropriate combination, crude lipids fractions were prepared to represent the successive intervals of extraction. These data are shown in Table I.

Reconstituted crude oils from each of the meats preparations, equivalent to the whole oils obtainable by straight through extraction of the variously prepared materials to the residual lipids levels achieved, were prepared by combining the crude lipids fraction in the proper proportions and order. In addition, the analytical composition of each of the reconstituted oils was calculated from the analysis and amounts of the crude lipids fractions composing each one. These data are shown in Table II.

Figure 1 presents a graphical representation of how the various crude oils were reconstituted. Generally speaking, extraction passes 1, 2, 3 combined to a residual extraction of 3.0% making up fraction I and, so on, as follows:

Passes	Fraction	Residual Lipids
1, 2, 3	I	100% to 3.0%
4, 5, 6, 7	II	2.0% to 2.0%
8, 9, 10, 11, 12	III	2.0% to 1.5%
13, 14	IV	1.5% to 1.0%
15	V	1.0% to 0.5%

In table I will be found the analytical data pertaining to the various lipids fractions. The method used permits separate examination of each of these fractions. The differences are tremendous for the three methods of preparation.

In the following discussions, it should be borne in mind that the initial fraction in all cases represents about 93 to 94% of the total lipids extracted for each method of preparation. Therefore the composition of this fraction exerts, percentage-wise the greatest effect on the composition of subsequent reconstituted oils. On the other hand, the final fraction represents the quality of lipids extracted in going from about 1.0% residual lipids to about 0.5%, the last drops of oil that are extracted to attain the ultimate in extraction efficiency. If this fraction is of low quality, and some of them are of exceedingly low quality, then the effect of even this small amount of oil, may be sufficient to degrade the whole lot to the point at which money is actually lost by extracting more efficiently.

The analytical data on various quality tests of the progressive fractions for the three methods of preparation are discussed and summarized under separate headings in the following paragraphs.

Free Fatty Acids: For tempered and raw meats there is a five-and nine-fold increase, respectively, in F.F.A. as the extraction progresses. However, the F.F.A. level for tempered meats is initially about twice that of the raw meats. For the cooked meats, the F.F.A. doubles approximately in the last fraction.

Gossypol: The gossypol content of the oil from the cooked meats is very low and actually tends to decrease toward the end of the extraction. For the raw flaked meats the gossypol content is initially about twice that of the cooked meats but the last fraction contains 6.25% - or over 200 times that of the corresponding fraction from the cooked meats. Similarly, for the tempered meats, the gossypol content is initially about five times that of the cooked meats but the last fraction contains 1.77% or over 50 times that of the corresponding fraction from the cooked meats.

Phosphatides: The phosphatide content of the oil from the cooked flakes is very low initially and although it increases to 0.69% in the final fraction, this value is also on the low side of the average cottonseed oil. By comparison, the phosphatide contents of the initial fractions from the raw and tempered flakes are respectively over 40 and 80 times as great, and the phosphatide content of the final fraction from the raw and tempered flakes are, respectively, 44 and 18 times as great, as the corresponding fractions from the cooked meats.

Neutral Oil: The neutral oil content of the fractions from the cooked meats shows practically no variation from 98.2% for the initial fraction to 96.7% for the final fraction. By comparison, the neutral oil content of the fractions from the raw meats drops from 96.1% to 56.2%, and the neutral oil content of the fractions from the tempered meats drops from 96.4% to 81.3%.

It will be seen from the foregoing that everyone of these quality factors favors the cooked meats by a tremendous margin.

In Table II will be found the analytical, refining loss and bleaching data on the reconstituted crude oils. These data show the quantitative and cumulative effect of the various fractions used to form the corresponding crude oils.

Note the exceptionally low refining loss values for the filtration-extraction cook. These low figures are substantiated by the correspondingly low chromatographic refining loss. The practical absence of phosphatides in these oils from cooked meats seems to be the main reason for the low refining losses. The low refined and bleached colors of the first fractions of the oils from raw flakes are of interest. These reflect the total absence of any heating above 120°F. prior to the removal of solvent. The color advantages, however, are not so great when the extractions are carried to the lowest residue lipids levels.

The information in Table III was assembled in order to rate the oils on a contract price basis taking into account premiums and penalties according to the trading rules. These findings are discussed and summarized below:

Raw Meats: Refining loss increases with degree of extraction, premiums decreasing from 3.6% down to 1.0%. Color is best of the three oils. All are prime and suffer no penalties for color.

Cooked Meats: Refining losses are lowest of all the oils and are about the same for all degrees of extraction. Premiums are consistently high for these low refining losses. All are above 4.5%. All of these oils have prime colors and suffer no penalties for color.

Tempered Meats: These refining losses are about the same for all degrees of extraction but are the highest of all the oils. The refining loss premiums are about 1.0%, compared with about 4.5% for the oils from cooked meats. These oils have dark colors and all of them suffer color penalties, which vary from about 1.0% to nearly 3.0% for the lowest residual lipids value.

Yields: It was not possible to include in this presentation calculations of the oil yields by the three methods. We expect to report on these later. A few generalized statements can be made, however, concerning oil yields to be expected, meal yields and meal quality.

1. Crude oil yields probably will be highest for the raw meats and lowest for the cooked meats because components such as gossypol and phosphatides are fixed in the meal by the cooking.

2. The high net premiums for the oils from the cooked meats are more important, dollar-wise, than any decrease in yield for this type of cook.

3. When yields and premiums are combined the cooked meats give a slightly higher income per ton of seed processed.

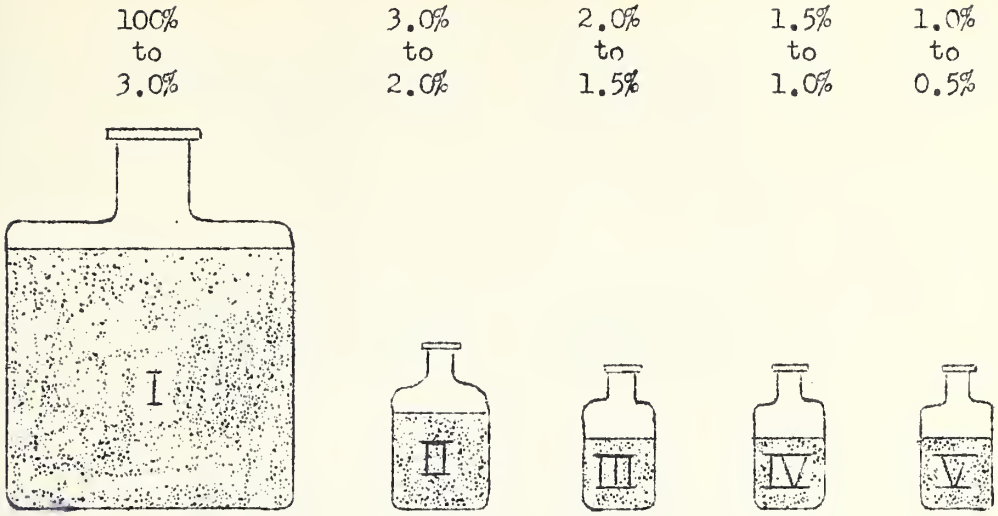
4. The fixing of phosphatidic material in the meal should tend to reduce its dustiness and should add some additional nutritional value.

5. The gossypol and alkali soluble values of these meals are all dependent upon the moisture, temperature, and time relationships maintained during tempering, rolling, cooking, extraction, desolventizing and toasting.

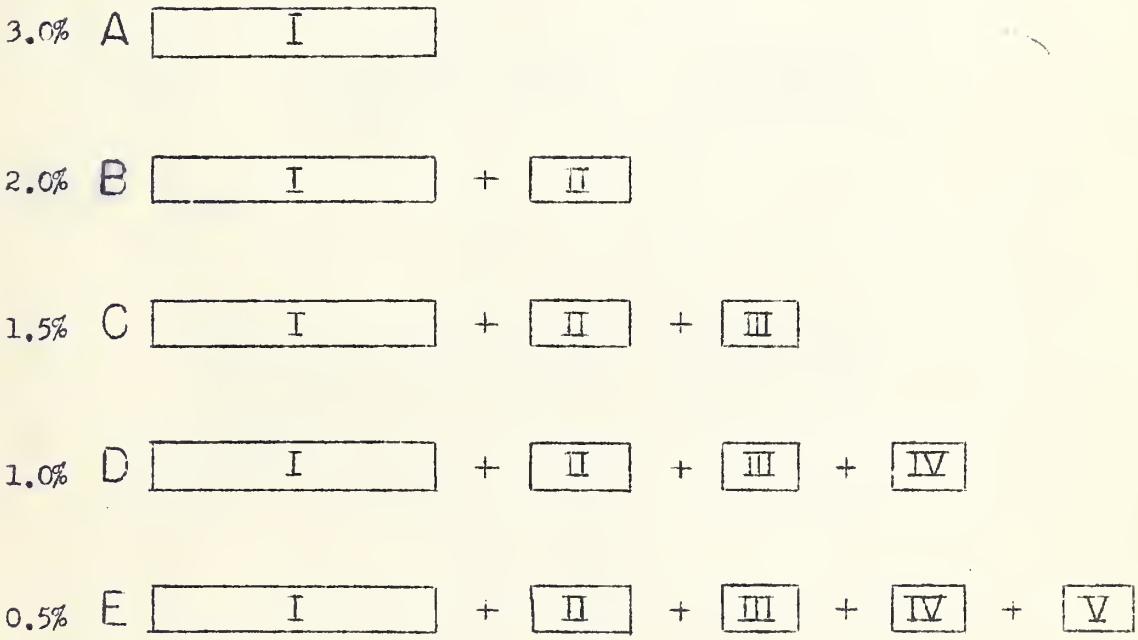
6. Meal from cooked meats can be produced with free gossypol values of from 0.03% to 0.05% and alkali solubilities of from 65% to 70%.

7. Meal from raw and tempered flakes will have a higher free gossypol content (0.50% or higher) and a higher alkali solubility (70% to 80%).

CRUDE LIPID FRACTIONS REPRESENTING
RANGES OF RESIDUAL OIL CONTENT



APPROXIMATE RESIDUAL LIPIDS:



RECONSTITUTED CRUDE OILS

FIGURE 1

TABLE I - ANALYTICAL DATA - CRUDE LIPIDS FRACTIONS

Meats Preparation	Material	F.F.A. as Oleic	Gossypol Total	Neutral Oil	Phosphatides (P x 30)
	Crude	%	%	%	%
	Lipid Fraction % of Total				
Raw	Lipid				
Flaked	I - 93.19	0.71	0.13	96.07	1.11
Meats	II - 3.16	2.43	1.37	89.36	7.50
	III - 1.04	6.16	4.25	76.56	15.00
	IV - 0.85	4.35	3.50	73.63	18.60
	V - 1.04	6.52	6.25	56.19	30.60
Filtration	I - 94.16	0.89	0.05	98.21	0.027
Extraction	II - 1.61	2.03	0.04	96.41	0.30
type	(III, IV, V)- 3.25	1.77	0.03	96.66	0.69
Cooked Meats					
Tempered	I - 92.88	1.58	0.25	96.41	2.25
	II - 2.62	3.09	0.22	92.76	4.38
Meats	III - 1.06	2.50	0.32	93.88	5.70
	IV - 1.04	2.67	0.70	91.44	5.97
	V - 1.31	8.28	1.77	81.27	12.54

TABLE II - RECONSTITUTED CRUDE OILS: CONPOSITION-ANALYSIS, AND REFINING AND BLEACHING DATA

Meats Preparation		Degree Extraction	Analysis Reconstituted Crude Oils 1/					Refining and Bleaching Test			
		Residual Lipids	F.F.A.	Neutral Oil	Gossypol	Phosphatites	Chromatographic Refining Loss 2/	Alkali Refining Loss	Alkali Refining Color	Bleach Color
		%	%	%	%	%	%	%	Red	Red
Raw	A	3.37	0.75	96.07	0.130	1.11	3.93	4.18	4.12	0.96
	B	1.84	0.82	95.84	0.171	1.32	4.15	5.13	5.40	1.62
Flaked	C	1.32	0.84	95.64	0.210	1.46	4.36	5.37	5.80	2.02
	D	0.89	0.85	95.45	0.233	1.61	4.55	5.69	6.30	1.80
Meats	E	0.37	0.90	95.04	0.296	1.92	4.95	6.25	7.00	2.33
Filtration	A	2.46	0.89	98.21	0.050	0.027	1.79	2.74	6.20	2.31
Extraction	B	1.79	0.83	98.18	0.050	0.032	1.82	2.92	6.50	3.31
Type	(CDE)	0.42	0.74	98.13	0.049	0.053	1.87	2.81	6.70	3.09
Cooked Meats										
Tempered	A	3.23	1.37	96.41	0.250	2.25	3.59	7.60	10.40	5.15
	B	2.07	1.30	96.31	0.249	2.31	3.69	7.59	11.40	6.53
Meats	C	1.59	1.31	96.28	0.250	2.35	3.72	7.60	11.60	5.92
	D	1.11	1.44	96.22	0.255	2.38	3.77	7.16	12.00	6.25
	E	0.51	1.49	96.03	0.275	2.52	3.97	7.52	14.00	8.40

1/ Calculated.

2/ 100 less percentage neutral oil.

TABLE III - EFFECT OF DEGREE OF LIPIDS EXTRACTION ON OIL VALUE

Extraction Run		Degree Lipids Extraction		Premiums (+) and Penalties (-) (contract price basis)			Unit Value of Oil Contract Price basis
		Residual Oil	Total Oil	Refining loss	Color	Net	
		%	%	%	%	%	%
1 Raw Materials	A	3.37	93.19	+ 3.6190	None	+ 3.6190	103.6190
	B	1.84	96.35	+ 2.8025	None	+ 2.8025	102.8025
	C	1.32	97.39	+ 2.7225	None	+ 2.7225	102.7225
	D	0.89	98.24	+ 2.4825	None	+ 2.4825	102.4825
	E	0.37	99.28	+ 1.0625	None	+ 1.0625	101.0625
2 Filtration-Extraction Cook	A	2.46	94.16	+ 4.6590	None	+ 4.6590	104.6590
	B	1.79	95.77	+ 4.5600	None	+ 4.5600	104.5600
	(CDE)	0.42	99.02	+ 4.6425	None	+ 4.6425	104.6425
3 Tempered Meats	A	3.23	92.88	+ 1.0500	- 1.2936	- 0.2436	99.7564
	B	2.07	95.50	+ 1.0575	- 1.7558	- 0.6983	99.3017
	C	1.59	96.56	+ 1.0500	- 1.8480	- 0.7980	99.2010
	D	1.11	97.60	+ 1.3800	- 2.0425	- 0.6625	99.3375
	E	0.51	98.92	+ 1.1100	- 2.9594	- 1.8494	98.1506

EXTRACTABILITY OF RAW AND COOKED COTTONSEED FLAKES

By

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Extraction rate studies of oleaginous materials have been widely reported in the literature, and a number of theories have been advanced to explain the mechanism of solvent extraction. These studies indicate that an ordinary oilseed particle is highly complex in cellular structure and that the oils or lipids contained in the material as prepared for extraction by the usual operations of conditioning, flaking, cooking, etc., is present partly as "free oil" which dissolves quite readily in the solvent, and "diffusible oil" which gets extracted at a slow diffusible rate, and that extraction takes place by a combination of solution, wetting, dialysis, osmosis and diffusion. Low residual lipids in the extracted meal is one of the primary requirements of a good solvent extraction process.

Direct extraction of cooked cottonseed flakes as compared to raw flakes has not been extensively studied. Since solvent extraction systems such as the filtration-extraction process depend so importantly upon cooking, it is essential to determine to what extent cooking affects extractability. Also, since the above stated process is unique in that extraction of the oil takes place almost exclusively in the most concentrated or product miscella, it is necessary to know to what extent extractability is influenced by the degree of concentration of the miscella. It was the purpose of this investigation to devise a suitable method to determine extractability, and to compare the rate and degree of extraction of raw and cooked cottonseed flakes of various thicknesses up to .025" in various concentrations of miscella up to 50% oil by weight.

A number of methods were investigated. The method of Wingard and Shand upon thorough testing was found to be a simple and workable procedure for determination of extraction rates in solvent or dilute miscella, but certain modifications and also precise experimental manipulations were necessary to enable accurate and reproducible extraction rate results in miscella concentrations up to 50%. The modified apparatus and the procedure in carrying out a typical test was described in detail. It consists, briefly, in rapidly agitating a weighed quantity (ca. 130 gm.) of the material in a 3000 c.c. flask with a weighed quantity of solvent or prepared miscella (10:1 solvent-flakes ratio), and to measure the rate of progress of the extraction by withdrawing and analyzing filtered samples of the oil solution at time intervals of 7.5, 15, 25, 40, and 60 minutes. The percent residual or undissolved lipids can be calculated from the difference between weight (by analysis) of the oil contained in the original material and that accounted for in the oil solution.

The cottonseed meats were prepared from a single lot of prime cottonseed. The seed was previously adjusted to the optimum moisture (8.5-9.5%) estimated to yield firm and stable flakes. Only the hull-free whole meats were used to prepare the flakes. The cooked flakes were prepared by the standard wet cooking procedure recommended for efficient filtration-extraction, followed by drying and crisping. Oils used for making up the different strength miscellas was high grade deodorized salad oil. Solvent was commercial grade hexane of negligible residue content.

A total of 18 extraction tests was made on the raw and cooked flakes of the 3 selected thichnesses of .005, .015, and .025". This comprised testing each flake thickness in the three miscella concentrations of 0, 25, and 50% oil. Residual lipids values were computed on the basis of the percent lipids contained in the raw and the cooked flakes as determined by the A.O.C.S. official method, but using hexane as the solvent. The raw flakes analyzed 37.06% lipids; the cooked flakes 35.68%. The data obtained at each miscella concentration was presented in the form of curves showing residual lipids content versus time, and by a bar chart which integrated all of the results, and enabled convenient comparison of the effect upon extractability of cooking, flake thickness, and miscella concentration.

The results showed that cooking improves both the rate and the degree of efficiency of extraction, regardless of the concentration of the extracting miscellas, of all flake thicknesses but the very thin (.005") size. The improvement can probably be attributed to rupture of oil cells by cooking, to the smaller average particle size of the flakes after cooking, and to the fact that cooking under the specified conditions binds the bulk of free gossypol in the meal and renders the phosphatide components practically insoluble in the hexane miscella. Also apparent is that the above changes brought about by cooking appeared to exert no beneficial effect when the flakes are rolled as thin as .005". Also demonstrated is that both the raw and the cooked flakes, at each of the miscella concentrations exhibit decreased extractability with increase in flake thickness, as would be expected.

The results show definitely that the effect of increased miscella concentration, for both the raw and the cooked flakes of the medium and thick sizes is to slow down the initial rate of extraction. The effect is also to carry extraction of the cooked flakes of all thicknesses, to lower residual lipids contents. In the case of the raw flakes, however, the effect is to improve the extractability of only the very thin flakes.

March 7, 1955 - Afternoon: Chariman, Allan K. Smith, NURB

UTILIZATION OF FATS AND OILS IN INDUSTRIAL CHEMICAL PRODUCTS

By
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Continued high production of edible and inedible fats, cottonseed, and soybeans, and loss of markets to competitive products have resulted in a surplus of fats and oils that appears to be a continuing one. An intensive research effort to discover new derivatives for industrial utilization offers the best possibility of solving the problems of surplus fats.

Analysis of several important fields of use for fats, oils, and their derivatives in industrial products shows that chemical modification of fats and oils has resulted in significant new developments. However, the total research effort has not been sufficient to prevent inroads by competitive products and to keep up with increasing production. Many opportunities appear to exist for increased utilization of fats and oils in industrial products, but it will be necessary to prepare and evaluate a wide variety of new derivatives of fats and oils to determine those derivatives having the greatest potentialities for industrial use.

In the field of resinous products and protective coatings, the development of polyamide resins is an important example of the results of research. These resins, obtained from dimerized fatty acids and diamines, have found increasingly wide application as heat-sealing and moistureproofing agents, adhesives, and lacquers. Recently, it has been found that epoxy resins can be combined with polyamide resins to give resinous products having unusual properties. Polyamide resins are also finding increasing use in gelled paints. Epoxy resins can also be cured with fatty acids and other non-fatty products. Alkyd resins consume large quantities of fatty acids and non-fatty derivatives for modification.

Fats and oils have recently become more prominent in plasticizers as a result of development of epoxidized oils and of "internal plasticizers" like vinyl stearate. Synthetic lubricants for aircraft require increasingly large amounts of dibasic acids, some of which are derived from domestic fats and oils. A tremendous potential market exists for inexpensive synthetic automotive lubricants for use in cold climates, but it does not appear that fatty acid derivatives have yet been explored extensively for this purpose.

Over the past 10 years, synthetic detergents have made extensive inroads into markets formerly supplied by soap. The development of detergents based on sulfated fatty alcohols has helped to regain some of these lost markets.

In all major fields of use for fats and oils, the contribution of research in providing new products and in increasing utilization is evident. There is no reason to believe that all useful applications for fats and oils have been found. New dibasic acids, polyfunctional molecules, polymers, and resinous materials can be obtained readily from fats and oils. These should find use as modifiers for alkyd resins, epoxy resins, and other resinous compositions, as bases for synthetic lubricants and detergents, and as raw materials or intermediates for plastics and coating compositions. It seems certain that intensive research will in time lead to the development of many new uses for fats and oils that may prove to be as important as any uses for these materials that we know today.

REVIEW OF NUTRITIONAL RESEARCH ON SOYBEANNOIL MEAL

By

Allan K. Smith
Northern Utilization Research Branch

Soybean oil meal (SOM) on a protein-equivalent basis is expected to supply about 72 percent of the vegetable protein going into animal feeds for 1954-55. The two factors which give SOM a special value in mixed feeds are (1) its high protein content (44 percent), and (2) its high lysine content (2.8 percent). In corn the average protein and lysine values are 8.9 and 0.17 percent, respectively.

Lysine is one of the 11 indispensable amino acids or protein chemical units which animals ultimately must derive from a vegetable source. Lysine is a most critical essential amino acid (EAA) in feeds, especially for those containing a high percentage of corn or other cereal grains. A deficiency of one or more of the essential or indispensable amino acids will result in depressed appetite, inefficient utilization of feed, and poor growth rate. The protein and lysine levels established for broilers are 20 and 0.9 percent, respectively. For swine, the recommended protein level varies from 12 to 18 percent, depending on the age of the pig; the younger pigs getting the higher protein feeds. The required lysine level for swine has not been definitely established, but appears to be in the range of 0.72 to 1.0 percent. Thus, it is apparent that SOM plays a very important roll in complementing the protein and lysine values of corn in mixed feeds. The only important commercial protein concentrates higher in lysine than soybean oil meal are those derived from animal sources such as meat scrap and fish meal.

None of the vegetable protein concentrates contain all the EAA in the proper proportion or balance for optimum feed results. It is difficult to mix the cereals and the protein concentrates to attain both desired protein level and EAA balance at the same time. For example, a level of 20 percent protein requires 1 part SOM to 2 parts corn, and this combination has a lysine content of 1.04 percent, somewhat higher than that required for broilers. In making a swine feed with a combination of 1 part SOM to 8 parts corn, a protein level of nearly 13 percent is obtained but its lysine content is only 0.46 percent. Thus, for optimum growth of swine, additional lysine must be obtained from some other source such as fish meal. After the lysine requirements of a feed have been met, then it often happens that some other EAA becomes critical and will require supplementation from another protein source.

However, the critical nature of lysine in feeds suggests that the value of soybeans could be increased if their lysine content can be raised to a higher value. This is a collaborative project for the research chemist and the plant breeder; the research chemist to develop improved methods for lysine analysis necessary for use in plant selection and cross-breeding. Increasing the quality of the protein in the soybean oil meal would be expected to increase its value in relation to other feeds, and perhaps this improvement might be enough to eliminate the use of synthetic nitrogen compounds in cattle feeds, thereby, increasing utilization of farm crops.

RELATION OF REFINING TREATMENT TO COLOR AND STABILITY OF SOYBEAN OIL

By

R. E. Beal
Northern Utilization Research Branch

The conversion of crude soybean oil to a product suitable for use as shortening, margarine, or a salad oil is accomplished by the successive steps of refining, bleaching, hydrogenation, in the case of shortening or margarine, and deodorization. With the exception of hydrogenation, the object of these treatments is the removal of undesirable impurities from the oil. The proper refining treatment removes substantial amounts of free fatty acids, phosphatides, color bodies and other materials from the crude oil so that a finished oil with light color, good flavor and flavor stability may be obtained. From the standpoint of the amount of impurities removed, refining may be considered the most important of the processing steps.

Crude soybean oil may be refined by intimately mixing it in controlled proportions with an aqueous solution of caustic soda followed by controlled heating, to coalesce the impurities, and centrifugal removal of these substances from the refined oil. In order to reduce refining losses to a minimum it is now preferred to conduct the refining in two stages. In the first stage the oil is treated with an aqueous solution of either caustic soda, soda ash, or ammonia in an amount sufficient to neutralize the free fatty acid in the oil. After removing the soapstock from this treatment by centrifugal separation, the oil is treated in the second stage with a sufficient amount of an aqueous solution of caustic soda to reduce the color and phosphatide content of the oil to a desired level.

The technology of refining is largely concerned with the selection of the proper strength and amount of caustic soda solution to achieve a desirable degree of purification with a minimum loss of neutral oil. Experiments conducted on a pilot-plant scale indicate that the phosphorous content of an oil is a very satisfactory criterion for determining the optimum amount of caustic to use for refining crude soybean oil. The phosphorous content of the deodorized oil was found to be between 1.5 and 10 parts per million for best stability and color. Dilute caustic was found to be more effective for removing iron and phosphorous from a crude soybean oil and it also left more of the antioxident, tocopherol, in the refined oil. A 0.05-percent excess of caustic soda in 8° Baumé solution was found to reduce the iron and phosphorous content of a crude oil to the same extent as a 0.3-percent excess of caustic soda in 20° Baumé solution. Both over-refining and the use of strong caustic are detrimental to oil quality.

COUNTERCURRENT FRACTIONATION OF VEGETABLE OILS

By
Lyle E. Gast and Herbert J. Dutton
Northern Utilization Research Branch

Vegetable oils like petroleum oils are not a single compound but are composed of a mixture of components. There is no reason to believe that the components placed in soybean oil by mother nature for the benefit of the soybean are necessarily the best combination for a paint oil or an edible oil. The trend in the vegetable oil industry like the trend in the petroleum industry is to make tailor-made products for specific uses out of the mixture mother nature has provided us.

The distillation processes so widely used by the petroleum industry for the fractionation of crude oils is generally not applicable to vegetable oils because of their low volatility. Certain adsorption processes have been used in the laboratory for separation of fatty compounds but they are unlikely to succeed commercially because of the large quantities of adsorbents and solvents required to separate a small amount of oil. Crystallization is a common technique for fractionating fats, and it is used on a commercial scale by vegetable oil and fatty acid manufacturers. It suffers, however, from the defect of being applicable only in special cases and is inevitably a slow batch process.

The fractionation of fats of liquid-liquid extraction or by virtue of their differential solubility is a comparatively recent development which has already been applied on a commercial basis. The laboratory counterpart of commercial liquid-liquid processes has given separation of fatty compounds heretofore unobtainable by the chemist. Although commercial installations have not attained the separatory power of laboratory equipment, they have none the less performed useful and practical separations. Under a favorable price situation, soybean oil is fractionated to yield a paint oil and an edible oil. This process has been carried out for a period of years with a capacity of one tank car per day. Another liquid-liquid extraction process is used commercially for the decolorization and refining of animal tallows. Both the fractionation of fats and the decolorization of tallow are conducted in gravity columns. It is possible that these gravity columns will be replaced in the future by centrifugal contractors that, despite their small size, have resolving power greater than that of gravity columns and a capacity up to 25,000 gallons an hour. Liquid-liquid extraction processes and the resultant tailor-made fats appear to be rising on the horizon in fat and oil technology.

RESEARCH ON THE PROCESSING OF SOYBEAN OIL MEAL

By
Allan K. Smith
Northern Utilization Research Branch

The heat treatment of soybean oil meal is an essential step in processing soybeans in order to develop maximum nutritional value. During the toasting process the meal should have a moisture content of 15 percent or higher as dry toasting of solvent meal does not improve nutritive value.

The time of heating depends upon the temperature. Heating at a steam pressure of one atmosphere for 45 minutes gives good results. Laboratory tests have indicated that variations of as much as 10 minutes from this value will have no significant effect. At a steam pressure of 15 p.s.i., a treatment period of 15 minutes is adequate. At this higher temperature the time factor must be controlled more precisely than for atmospheric treatment as the meal is more sensitive to overtoasting. One of the effects of overtoasting is to destroy the lysine and cystine of the protein in the meal and thus cause a reduction in nutritional value.

Many processors are now controlling their toasting operations by laboratory tests. The two most popular tests are (1) the modified Caskey-Knapp test which determines the activity of the urease in the meal by a pH change method, and (2) the solubility of the protein in water, now referred to as the Nitrogen Solubility Index (NSI).

The pH change test is made by adding a buffered urea solution to the meal and measuring the change in alkalinity with a pH meter. The alkalinity is caused by reaction of urease with urea to form ammonia. If the meter shows no pH change, then urease has been entirely destroyed, indicating the meal may have been overtoasted. If the pH change is in the range of 0.02 to 0.25, then it is properly toasted. A change in pH greater than about 0.3 indicates the meal is undertoasted.

In the NSI test, the nitrogen solubility is determined by adding 2.5 grams of the meal to 100 ml. of water and shaking for 30 minutes. The insoluble part of the meal is removed in a centrifuge and an aliquote of the solution taken for a Kjeldahl nitrogen analysis. The percentage of soluble nitrogen is then calculated. When this method is used, a meal toasted at atmospheric steam pressure should have an NSI value in the range of 12-16 percent; whereas, a pressure toasted meal would have an NSI of about 10-13 percent. Expeller meals usually give NSI value of 9-10 percent. Lower values for any of these methods indicate overtoasting of the meal.

The toasting operation destroys some toxic or antinutritional components which occur in soybeans. These undesirable factors have not been specifically identified, but they are known to occur in very small amounts. The tests used for control of optimum toasting are not dependent directly on the antinutritional factors in the meal, but the changes in urease activity and nitrogen solubility with toasting are known to take place at about the same rate as nutrition and therefore can be used as control tests. When nutritionists and chemists have identified the antinutritional factors in unheated soybeans, perhaps new and better tests for control of toasting will be developed. The toasting of soybean

oil meal to its optimum nutritional value is important if it is to maintain its top position among other vegetable protein concentrates used in mixed feeds.

March 8, 1955 - Morning: Chariman, Dr. W. W. Fetrow, FCS

ANALYSIS OF OPERATIONS OF COOPERATIVE COTTONSEED AND SOYBEAN OIL MILLS

By

Daniel H. McVey
Farmer Cooperative Service

Dr. Fetrow introduced the subject by expressing appreciation to the mills for furnishing the data and lauded the spirit of cooperation that exists among the group. He explained how careful we had been to keep the information on a confidential basis. Dr. Fetrow also stated that we were proud of the timeliness of the reports. Data were collected on field trips in October and November 1954, and the results started flowing back to the mills in January 1955.

Mr. McVey distributed copies of the following reports and discussed some of the highlights:

1. FCS Advisory Report 29 - "Electric Consumption, Power Rates and Power Costs at Cooperative Cottonseed Oil Mills, 1953-54 Season".

2. FCS Advisory Report 30 - "Labor Utilization in Cooperative Cottonseed Oil Mills, 1954-55 Season".

3. FCS Advisory Report 31 - "Report to Managers and Directors of Cooperative Cottonseed Oil Mills on Operating Results for 1953-54 Season".

4. FCS Advisory Report 32 - Sampling, Seed Analysis, Extraction Efficiency and Product Analysis for Cooperative Cottonseed Oil Mills, 1953-54 Season".

5. FCS Advisory Report 33 - "Report to Managers and Directors of Cooperative Cottonseed Oil Mills on Operating Results for Seasons, 1947-48 to 1953-54 by Areas".

6. FCS Advisory Report 34 - "Report to Managers and Directors of Cooperative Cottonseed Oil Mills on Operating Results for Seasons 1947-48 to 1953-54 by Type of Mill".

7. FCS Advisory Report 36 - "Labor Utilization in Cooperative Soybean Oil Mills, 1954-55 Season".

8. FCS Advisory Report 37 - "Electric Consumption, Power Rates and Power Costs at Cooperative Soybean Oil Mills, 1953-54 Seasons".

9. FCS Advisory Report 38 - "Report to Managers and Directors of Cooperative Soybean Oil Mills on Operating Results for 1952-53 and 1953-54 Seasons."

10. FCS Advisory Report 40 - "Bean Analysis, Extraction Efficiency and Product Analysis for Cooperative Soybean Oil Mills, 1953-54 Season."

11. FCS Advisory Report 41 - "Operating Expenses of Cooperative Soybean Oil Mills, October 1, - December 31, 1954."

Copies of these reports have been furnished each of the mills and the Banks for Cooperatives. A set of the reports on cottonseed was given to each of the soybean mills and the cottonseed mills received a copy of each of the soybean reports. The confidential nature of the reports was pointed out.

Considerable discussion of the operating results took place as well as labor requirements and wage rates. In general, the mills that pay the highest wage rates are the most efficient users of labor. With respect to the sampling and analysis of raw materials and manufactured products, it was agreed that the cottonseed mills do a lot more testing than the soybean mills. This is probably due to the fact that soybeans do not vary in quality nearly so much as cottonseed. The group asked that the same information be obtained another year and the same type of reports prepared.

March 8, 1955 - Afternoon: Chairman, W. W. Fetrow, FCS

TAX PROBLEMS OF COOPERATIVES *

By

W. N. Stokes, President
Houston Bank for Cooperatives

The Background

The current tax situation of farmer cooperatives must be considered in the light of the long tax history of such organizations.

Let us recall that prior to 1951 farmers' cooperative organizations engaged in marketing the produce of their members' farms or in purchasing their supplies were exempt generally from payment of Federal income taxes. There were certain defined standards:

(1) Dividends on stock should not exceed 8% or legal interest rate of the incorporating state, whichever is greater.

(2) Substantially all voting stock must be in hands of producers using association facilities.

(3) Accumulation and maintenance were permitted of reserves required by state laws, or of other reasonable reserves for necessary purposes.

(4) Non-member business must not exceed member business.

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* I have made extensive use in this paper of a fine article on cooperative taxation by Mr. Ray Mischler appearing in the Fall 1954 issue of the Cooperative Accountant.

The 1951 amendments were not designed to change radically the fundamentals of cooperative tax exemption. Their primary purpose was two-fold: (a) To remove the so-called "unallocated reserve," whereby cooperatives could set aside earnings into untaxes reserves; and (b) to furnish the Internal Revenue Service a means by which non-cash income could be traced into the hands of cooperative patrons——in other words, to tighten up enforcement.

Thus: Exempt cooperatives now file income tax returns just as do other corporations; their returns differ from the standard primarily by the addition of deductible items: (a) Amounts paid as dividends on capital stock; and (b) amounts allocated as patronage refunds, whether paid in cash, merchandise or any other way that discloses to patrons the dollar amount allocated to them.

Perplexing Questions Under New Amendments

Let us first dispose piecemeal of a number of perplexing problems which the 1951 law has posed:

Losses: Perhaps the most difficult is the question of how a cooperative should handle its losses. Should a cooperative "allocate" losses to patrons on the same basis as earnings are allocated? If so, may the patrons deduct such losses from their personal income? These questions are not answered. The regulations do say that an exempt cooperative may reduce its taxable income under the "carry-back and carry-forward" plan allowed general corporations. Granted that this would be difficult to administer in the case of a true cooperative operation, it does offer a degree of relief from heavy losses so far as payment of taxes to the Government is concerned.

Undelivered dividends and refunds: When determination is made that the funds are undeliverable, the income either must be reallocated or taxes paid.

Charitable contributions: The general law allows deduction by corporations of charitable contributions up to 5% of the corporation's "net taxable income". If a cooperative operates on such basis that it has no "net taxable income", the inference seems inescapable that it would not be able to deduct such contributions.

Contributions to Organizations Engaged in "Lobbying"

Cooperatives should not ignore the implications of Roberts Dairy Company v. Commissioner, 195 F. (2) 948, where it was held that contributions to the National Tax Equality Association were not deductible items under the tax laws. Obviously if cooperatives make direct expenditures for the purpose of influencing legislation, or contributions to organizations for such purposes, the funds so spent are not deductible, and taxes should be paid on them.

Taxation of Patronage Refunds Not Paid in Cash

Are patronage refunds not paid in cash by an exempt cooperative nevertheless taxable to the patron? If so, is the income measured by the market value at delivery of the evidence of the refund, or by its stated face value?

The regulations of the Internal Revenue Service say definitely that the proper measure of value is the stated face amount. A number of court decisions has held to the contrary---that the taxable value is determined by the market value at the time of issue.

Which view eventually will prevail? And which should cooperatives and farmers now follow?

In answering these questions the courts will try to ascertain the intent of the Congress when the law was passed. This intent conventionally is determined by two approaches, the first "internal"---that is, by examining the language of the law itself; what do the words mean?---and secondly, by looking at the "legislative history" of the law---what was the purpose in passing it? What did the witnesses and committees say was intended?

There is much to be gleaned from an "internal" examination of the 1951 amendments. Most significant is the requirement that in order to escape taxes on income, a cooperative must disclose to the patron the dollar amount of the dividend, refund or rebate allocated to him. Why disclose? Why advise? A tax law does not impose such requirements without purpose, and it seems obvious here that this purpose was to inform the patron of the amount of his earnings in the cooperative in order that he may be able to report such income properly.

But the law does not stop here. It adds an additional requirement that a cooperative must furnish the Internal Revenue Service with a list of patrons receiving income, including allocations not paid in cash, where such amounts equal or exceed the sum of $100.00. If it so desires the Service may require inclusion of patrons who receive less than this figure. You may ask the same questions regarding this provision. Why would the Government want information regarding such earnings if there was no intent to tax them?

From the "internal" view it thus appears evident that Congress was attempting to tax cooperative income, either in the hands of the cooperative or in that of the patron.

Now, what about the "external evidence"? What were the Committees of Congress advised regarding these matters?

The record of the hearings on the 1951 amendments is replete with references by cooperative representatives that income on which an exempt cooperative does not pay a tax is chargeable directly as income to the patron. Consider these significant quotations:

Eugene Hensel, Counsel for National Association of Cooperatives, Chicago:

> "Such income does not escape taxation. It is taxed in the hands of the patron, where it properly should be taxed, to the extent it constitutes net taxable income to the patron. The effect of the organization and operation of true cooperatives is not to avoid or escape taxation, but to shift the point at which the tax is assessed". (Page 2615 of the official publication of the hearings.)

And again quoting Mr. Hensel:

> "As long as there is a contractual agreement between the cooperative corporation and its patrons authorizing the retention of refunds, or any part thereof, for capital purposes, the capital is no more income to the cooperative than the receipt of payment for stock subscriptions is income to the United States Steel Corporation or any other non-cooperative corporation." (Page 2623, Hearings)

Mr. Karl Loos, representing the National Cooperative Milk Producers Association, National Federation of Grain Cooperatives, National Association of Cooperatives and the National Council of Farmer Cooperatives:

> "These distributions are made in many forms---capital stock, revolving fund certificates, certificates of indebtedness, and so forth. I do not think it makes any difference what the form is, as long as there is something tangible that the recipient gets. And when he gets it, that is income to him in the amount of cash it represents as a distribution. And there we have the crux of the situation." (Page 3033, Hearings)

These are but samples of the many references to this principle. There were no witnesses who took a contrary view.

We now must consider the manner in which the courts have construed this law. Uniformly they have rejected the theory advocated by Mr. Hensel, Mr. Loos and other cooperative witnesses before the committee.

Perhaps the case most widely quoted is Carpenter v. Commissioner. This case was considered first by the Tax Court in 1953 (20 T.C. 603). It arose before passage of the 1951 amendments, but since the amendments were directed to means of enforcements rather than to principle, this is not considered significant. Fosgate Fruit Growers was an exempt cooperative. The taxpayer received refund certificates representing deductions retained by the cooperative for capital purposes. The certificates were retirable in the sole discretion of the board of directors of the cooperative. It was determined that the certificates were without market value at time of issue.

The Tax Court held that the certificates were not taxable to the patron in the year of issue, since they had no actual market value. The Court said:

> "The cooperative and its patrons were different entities and we do not think it necessarily follows that what is excludable from the income of one, whether the cooperative be taxable or tax exempt, automatically becomes income to the member."

On the question of "constructive receipt" (the legal presumption that the patron should be assumed to have received the income, since by his contract he authorized the cooperative to retain it), the Court had this to say:

> "The petitioner never had any real dominion and control over the funds represented by the certificates. The decision to retain the funds in the business rested solely with the directors. The certificates themselves had no fair market value and we do not see that whether or not the cooperative was obligated to issue such certificates adds anything significant to the situation."

The Carpenter case was affirmed by the United States Circuit Court of Appeals, 5th Circuit, on March 2, 1955. The Court in a short opinion followed the theory of the Tax Court and held that the income was not taxable to the patron.

There are other cases similar to the Carpenter case. In Farmers Grain Dealers Association of Iowa v. United States, 116 Fed. Supp. 685, the United States District Court held that the patron "had no control" over the funds represented by the certificates. "It is the command of the taxpayer over the income which is the concern of the tax laws." It was held that the income was not taxable to the patron. Caswell's Estate v. Commissioner, decided by the Circuit Court of Appeals, 9th Circuit, 211 Fed. (2d) 693, held that "commercial reserve" certificates were not taxable to the patron. There are other decisions to the same effect.

Note that in none of the decided cases have the courts considered: (a) The language of the 1951 amendments---the "internal evidence," nor (b) the legislative history of the laws---the "external evidence." The cases were decided on the basis of conventional principles of corporation and contract law without any consideration whatever of the fact that cooperatives have received separate and specialized treatment under the tax laws.

The Legal and Moral Lessons

The issues of the Carpenter and other cases remain unsolved at this time. They will remain so until the Supreme Court of the United States has considered the cases, or until the Congress has removed the doubts by rewriting the legislation. What should be the attitude of cooperatives in the meantime?

Mr. Raymond Mischler, Attorney, Office of the Solicitor in the United States Department of Agriculture (and a very fine cooperative attorney) has given this valuable advice (Article in Fall 1954 Cooperative Accountant, page 54):

> "If there is a moral in all this---and I think there is---it is simply this: All who work with cooperatives and try to promote their best interests should do their utmost to see to it that---
>
> 1. The cooperative's bylaws and agreements are clear and specific on the point that the patrons, not the cooperative, own the income developed through their cooperative enterprise; and
> 2. These agreements are closely respected and followed in practice."

Mr. William G. Stacey, C.P.A., Salem, Oregon, in the Fall, 1954 Cooperative Accountant, adds this significant statement:

"The moral issue should not be overlooked. It simply is not right for cooperatives to amass strong capital structures through accumulation of retained margins without some sort of tax liability. We are emerging from behind a cloud of adverse public opinion and we certainly should not do anything that will nullify our progress.

"Let us pay our way taxwise. The most desirable way to do this is for the patron to assume the tax burden.

"In my opinion, one thing is dead certain. Taxes must be paid on cooperative margins---either by the patron or the cooperative."

GOVERNMENT SUPPORT PROGRAMS - SOYBEAN VIEWPOINT

By
Glenn Pogeler, Manager
North Iowa Cooperative Processing Association

Mr. Pogeler said the original idea of supports was good. They were designed to, and did, help in orderly marketing of farm products. Helped to spread out the movement of products over the entire year and helped to stabilize the markets. Helped to avoid depressing the price during the harvest season. Soybean farmers have learned to store beans and avoid the fall flut on the market. He recognizes that most of the soybean growers feel that there should be some floor so as to avoid disaster for the farmer. As a processor, Mr. Pogeler said he would like to see more emphasis put on marketing or selling. Increase the demand for products and let the laws of supply and demand begin to take over.

With respect to supports for the current year, Mr. Pogeler pointed out that he is a director of the National Soybean Processors Association and they had taken the position that they should not say whether the U.S.D.A. should support soybean prices or at what level. If the Department is going to support prices, the Association is interested. They want to know what the levels are going to be for soybeans and for competing crops particularly cottonseed. If soybeans are supported and cottonseed are not, then the soybean industry wants a support on soybean oil.

(Note: On March 16, 1955, the Department announced on oilseeds support program for the 1955 crop. Soybeans will be supported at 70 percent of parity, cottonseed at 65 percent and flaxseed at 65 percent. There will be no support on products.)

GOVERNMENT SUPPORT PROGRAMS (Continued)

COTTONSEED VIEWPOINT

By

Roy B. Davis, Manager
Plains Cooperative Oil Mill

Mr. Davis reviewed the history of the cottonseed support program. The Government actually bought the seed in 1949 and the mills did the crushing on a toll basis after competitive bidding. In 1950 and succeeding years the "package program" was used in which the Government would buy specified quantities of oil, meal and linters from the crushing mills at specified prices. For most mills, this afforded an ample crushing and profit margin. Due to the Korean War flare-up, no products went to the Government from the 1950 and 1951 crops. About half the 1952 crops was delivered to the Government. Mr. Davis believed that this program was a help to the soybean industry.

Mr. Davis pointed out some of the operating differences and customs between the two industries. Soybeans are handled as grain and a lot of beans are stored on the farm. Cottonseed is handled more as a perishable product and there is practically no farm storage, in fact, there is very little storage anywhere except at the crushing mills. With the cotton being harvested in 45 to 90 days, the mills must be prepared to accept enormous quantities of cottonseed in a very short time. With respect to protection against price declines, he pointed out that:

1. There are quoted market prices on soybeans and they can be hedged on the futures market. Crude soybean oil may either be sold forward or hedged on the futures market. The same is true of soybean meal.

2. There are no market quotations on cottonseed. Crude cottonseed oil cannot be sold on the futures market. Refined oil can be sold on the Board but crude is not deliverable against a refined oil contract. Forward selling is the only out. Cottonseed futures meal can be sold on the Memphis Board but delivery points are restricted to an area fairly close to Memphis which makes it impractical for most mills to use this market. Again, forward selling is the only avenue. There are no linter futures markets and a limited number of linter buyers. There are no futures markets for hulls and forward selling is difficult. They are sold pretty much as produced.

All this leaves the cottonseed crushers pretty well restricted to forward selling of products as a protection against price declines. Receiving huge quantities of seed in October and November and trying to make sales for delivery the middle of the next summer is difficult if not impossible. The result is that cottonseed prices to the grower become depressed during the harvest season. The price support program on cottonseed has acted as a floor on seed prices and has been a real protection to the grower. It has afforded another outlet for products, if necessary. That's why the growers and the cooperative mills have fought for a continuation of the cottonseed support program.

Mr. Davis concluded his remarks by saying that it was his opinion that the producers of both cottonseed and soybeans have a lot in common. The two groups should not be fighting each other but should work together for the good of all. He suggested that representative growers from each group have a meeting and discuss some of their problems.

March 9, 1955 - Morning: Chairman, D. H. McVey, FCS

NEW DEVELOPMENTS IN OIL MILLING

By
Earl Cecil, Manager
and
Ed Hudson, Superintendent
Ranchers Cotton Oil

Mr. Cecil led off the discussion by saying that they were one of the youngest cooperative mills - now in their fourth crushing year. They purchased a solvent plant that had never crushed cottonseed and had to do considerable work to convert it to cottonseed crushing. They have made many changes and additions since they started up. He cited, as a recent example, the use of carding machines from a spinning mill to blend small quantities of staple cotton with linters produced by the mill to make a better linter that will sell and sell for more money. They have found some very profitable outlets for their linters. Other examples are the extraction, refining, bleaching winterizing and deodorizing of the oil all in continuous process so that they can go to market with a finished salad oil. He stressed the importance of their laboratory both for experimental work and for the necessary control work. He also stressed the importance of teamwork among the personnel. He then asked the mill Superintendent, Ed Hudson, to tell the story of Ranchers.

Mr. Hudson illustrated his talk with 76 colored slides that were very effective. First, he showed several general outside views of the mill, such as:

1. Seed scales and sampling. The sampler is on the second floor and can step from the platform on to the seed load and not have to climb up from the ground. The seed auger has an electric motor that turns the auger and speeds up the sampling job. Samples are weighted on platform and dumped from there thru shaker screen built to comply with Government standards. Each load of seed is checked for moisture and trash before unloading.

2. Seed dumps which are conveyor belts and the seed trucks and trailors are unloaded from the side.

3. Outside seed storage. Store up to 30,000 tons of seed outside on pavement and cover with tarpaulin. They believe this to be cheaper than inside storage when county taxes and interest on investment are considered. They use thermocouples to show up hot spots. One seed house used to store and blend offgrade seed.

4. Hull and linter storage both outside.

5. Open wall solvent plant. Allows air to circulate but roofed against sun and rain.

6. Other outside shots of the office, meal building, linter building, boiler room, cooling towers, etc.

Mr. Hudson then explained some of the details of their processing operation and again used colored slides to illustrate his points. Some highlights:

1. All seed, including those stored outside, move to the mill through two feeder bins in the seed house so that any blend of seed can be run. Control of feeder bins screw speeds accomplished remotely from the lint room.

2. During the cleaning process, heat is applied to the seed which gives them a better cleaning and delinting job. Seed passes through a rock and shale trap before the Bauer machine so that unginned cotton and locks of lint can be recovered as motes free of rocks.

3. They operate 34 linter machines with two men per shift. They have built a shaler for each linter machine and improved the quality of lint by removal of large shale as well as hull pepper before the beaters. An automatic lubrication system covers 800 bearings, greasing each fifteen minutes, using 1½ barrels of grease per season and prolonging bearing life at least three years. A reclaim mote system was made by removing the float from a linter stand. All unginned seed, motes from linters, lint and shale discharges pass through a beater, then to reclaim machine, and on through 2nd beater. Mote recovery was raised from 6# to 22# per ton seed. Most of additional recovery formerly went to trash. Mote quality is also improved.

4. One man handles the bale press. They are using a new type buckle, that requires no bending of the ties. It is faster and there is less breakage. Two standard carding machines have been installed with air suction offtakes from the main dolfer. This air is from the first cut flue systems and blends staple cotton with lint as it enters the flue system.

5. One man handles the seed cleaning and separation jobs. Part of the hulls are ground and hull fiber is separated to blend with finished meal as a protein control. Lint recovered goes into motes.

6. For extraction they use the old hydraulic type cooker and prepress. Caustic soda is added in small quantities before extraction. The extraction tower is the vertical immersion type similar to the Old Allis-Chalmers.

7. The oil from the pre-presses is blended with miscella concentrate from the extractor and refined while still in the miscella state. Losses approaching Wesson loss are obtained.

8. Other processing steps bleaching and winterizing from the refinery before the hexane is removed. Deodorizing then takes place and a salad oil is produced. This is all a continuous process. Any one of the steps can be by-passed and any combination of steps can be used. Only two men per shift are used - one for preparation and pre-pressing and the other for solvent extraction and succeeding steps.

9. The hexane free meal moves from the solvent plant by air about 400 feet to the feed plant. Mixes using alfalfa, salt and minerals are made. Mixing materials are handled in bulk tote bins dumped into mix bins by a unique dumping device. Mixing is continuous using Syntron feeders for control. The additions of the soapstock obtained in the refining process to the meal enables them to make a very satisfactory pellet - 3/4" dia. range pellets, 1/2" dia. sheep pellets and crumbles are made. A bulk loader has been developed that eliminates dusting and separation of fines when loading rail cars. They experience no particular meal dust problems and demand for their feed has been good.

10. They have applied for patents on a lot of the equipment and processes used.

NEW DEVELOPMENTS IN OIL MILLING (Continued)

By

Roy B. Davis, Manager
Plains Cooperative Oil Mill

Mr. Davis explained that they had a 300 ton French vertical basket type extractor extracting 500 tons of cottonseed per day on straight extraction. He explained that they hadn't gone nearly so far as Ranchers in their set-up. At one time, they had a conditional contract for the installation of an ammonia refinery but finally decided against it primarily because they had no ready market for refined oil and there was no ammonia refinery in commercial operation. Their primary consideration has always been the improvement of their meal and cake. On further investigation, they cancelled the conditional contract for the refinery and installed degumming equipment. This consists primarily of two hermetically sealed centrifuges through which all the crude oil is run. The gums and lecithins, including some oil and fatty acids, removed by the centrifuges are continuously added to the meal in the desolventizer toaster. This has improved the appearance and handling quality of the meal

and enables them to make excellent pellets on an extrusion type pellet mill. Some feeding experiments are being carried on and there is some evidence that the feeding quality of the meal is improved. Oil quality is also better with a lower refining loss which increases their premium. The equipment already installed can all be used in a complete refinery if they decide to take that step later.

In connection with their operation they have found it necessary to set up a laboratory and hire technicians to do the necessary experimental and control work.

In response to a question, Mr. Davis said they had invested between $50,000 and $55,000 in the degumming equipment and had bought around $6,000 or $7,000 worth of laboratory equipment. They will have to buy some more. They have been able to save some money on analysis work formerly done by commercial laboratories.

March 9, 1955 - Noon: Chairman, Wilmer Smith, President
Plains Cooperative Oil Mill

A luncheon was served to the group including the members of the Board of Directors of the Plains Cooperative Oil Mill. After the luncheon, the Board of Directors (approximately 75) held their regular monthly meeting. The financial statement of the mill for the period ending February 28 was presented and discussed by Mr. Key, Assistant Manager of the Mill. A copy of this statement was given to each of the visiting mill managers for their files. It was interesting to the visiting managers and Directors to see the operation of so large a Board. Mr. Davis explained that they had such a meeting each month. They always serve lunch at noon and begin the business session immediately afterward.

March 9, 1955 - Afternoon: Chairman, Dr. W. W. Fetrow, FCS

MEMBERSHIP AND LOYALTY PROBLEMS

By

Clyde Grice, Manager
Mid-West Cooperative Oil Mill

Mr. Grice explained that their association was organized in 1942 and they bought an old worn out mill. It is a federated organization owned by some 30 cooperative gins. They struggled along until 1950 when they had a fire that burned up a good part of the mill. It was a good thing because when they re-built it they put up a good mill. It has been mechanized to use as little man-power as possible.

Their problem has been volume. They have had four years of drouth and neither the gins nor the oil mill has done much business. To further complicate things, their competition, who has plenty of money, has been after the seed produced by the cooperative gins. They often do not have a set seed price but pay whatever is necessary to get the seed. Since the gins have had financial difficulties, they have often sold some seed to the competition. This has hurt the mill by further reducing their volume. Mr. Grice expressed appreciation to the Plains Cooperative Oil Mill, which is a member of the Mid-West Mill, for selling them seed enough to have a fair run.

With respect to membership loyalty, the members are loyal as long as things are going in their favor. Is pretty sure that members are not kept well informed. When informed and the chips are down, most of the members will come through and support the organization.

Al Hazleton suggested that it might be a good idea for the cooperative mills not to have a seed price. Several of the cooperative cottonseed oil mills, of course, do not have an established price but advance something less than the market. Mr. Taylor said they advanced the price for rape seed at Altona.

MEMBERSHIP AND LOYALTY PROBLEMS (Continued)

By

Ralph Olson, President
Boone Valley Cooperative Processing Association

Mr. Olson mentioned how much they had enjoyed the meeting. It had been interesting and informative. The fact that such meetings get pretty technical sometimes presents some problems.

With respect to the membership and loyalty problems Mr. Olson brought out the following points:

1. When the Dave Douglas film was released, The Iowa Institute of Cooperation bought a copy of the film and began showing it throughout the State. By so doing, they were able to make comments showing up the faults of the film and thus combat the misleading features. It has been effective.

2. Most cooperatives aren't close enough to their members. They have trouble maintaining knowledge among the cooperative members as to what the cooperative is and how it operates. Members must be made to realize that the cooperative is <u>their</u> business and not just another place to do business. It takes constant work and education.

3. Many cooperatives are faced with stiff competition not only from private concerns but also from other cooperatives. This problem of competition between cooperatives is becoming very important in some areas. Such a situation intensifies membership problems.

Meeting for 1956

The group in attendance came to no conclusions regarding a meeting or meetings for the next year. They agreed that they wanted a meeting but wanted time to think about the kind of meeting, place and time. They asked that Dr. Fetrow poll the group at a later date.

Resolution

At the close of the conference, the following resolution was passed unanimously:

> Resolved that the members and officials of the Cooperative Cottonseed Oil Mills and Soybean Oil Mills formally express our appreciation to the Management, Officers and Staff of Plains Cooperative Oil Mill for the many courtesies, and generous hospitality extended our two groups at the joint meeting held in Lubbock, on March 7, 8 and 9, 1955.